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Estimating components of Mean-Squared Error as a means to evaluate mixed mode solutions to noncoverage error in telephone surveys

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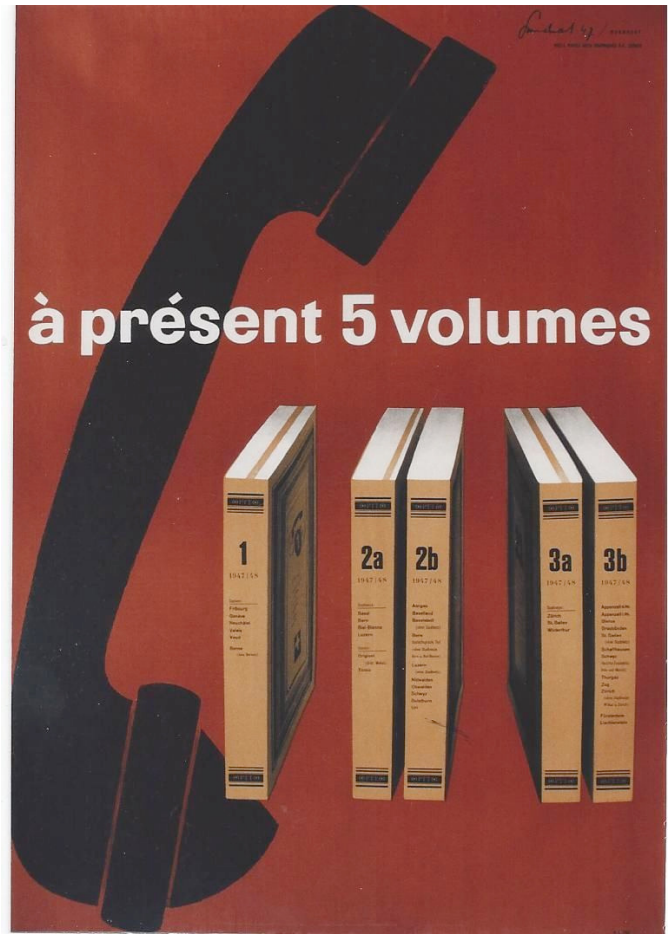
Motivation

- Strong tradition of CATI surveys in European market research, official statistics, and academic research
- Sharp recent decline in fixed-line telephone coverage
- Reduced coverage of traditional sampling frames – e.g. Swiss telephone directory



Motivation

- Survey organizations increasingly offer mixed mode solutions to address noncoverage in telephone surveys
  - Additional claim that they can reduce nonresponse error and overall fieldwork costs
  - Risk of confounded selection and measurement error often ignored
- Empirical basis for claimed benefits is still relatively limited
  - Not much known about the impact of mixing modes on TSE
- Biemer (2010; 2011) recommends estimation of Mean-Squared Error (MSE) for decomposing error into different sources to compare survey designs

Research Questions

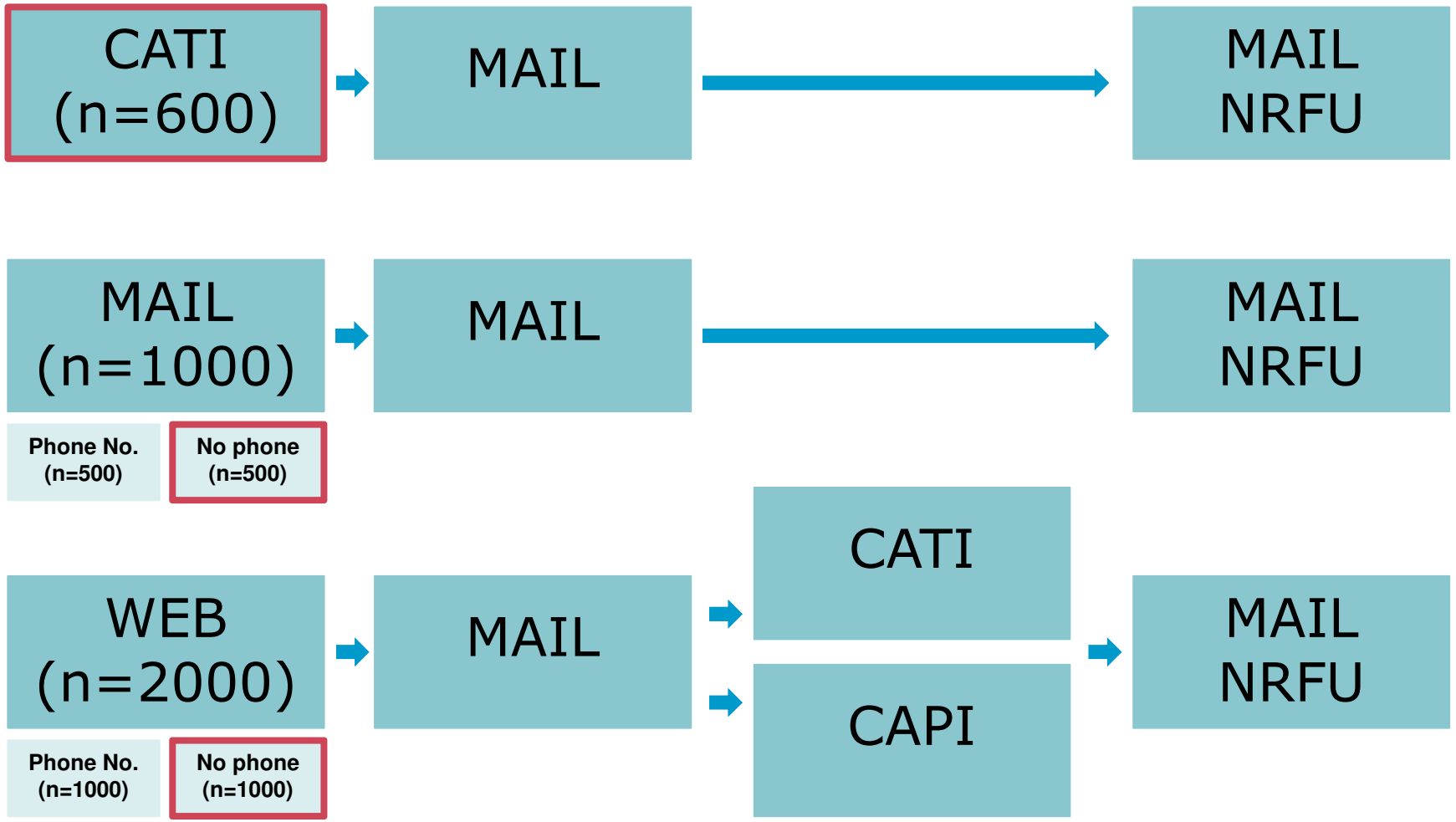
1. What is the effect of mixing modes of data collection on the total error of estimates?
   a. Is a reduction in noncoverage error as a result of mixing modes associated with larger nonresponse and/ or measurement errors
   b. Does a sequential mix of modes help to reduce nonresponse error?
   c. Is measurement error increased as a result of reductions in noncoverage and nonresponse error?

2. Which sources of error contribute the most to the total error associated with different types of survey estimate?
   a. How does this vary from factual to nonfactual survey questions?

Data

- Mode experiment, 2012-2013
- Probability sample of individuals from French-speaking Switzerland from SFSO population register
- Random assignment to single mode surveys in parallel
- Test of sequential mixing of modes to follow-up non-respondents
- Survey topic: Personal and Social Well-being
- 25 minute interview/questionnaire
- 10CHF unconditional cash incentive

Experiment Design



Experiment Design

	Survey 1	Survey 2	Survey 3
Phone No.	CATI n=600	CATI n=600	CATI n=600
No Phone No.	Not Covered (41.2%)	Mail n=500	Web + Mail n=1000
RR	60.7%	60.6%	61.3%

Data

- Two sources of data for investigating survey error:
  1. Auxiliary data from the sampling frame based on population registers and maintained by the SFSO
  2. Respondents to a nonresponse follow-up survey (no repeated measurements)

- Decomposition of errors possible for:
  1. Socio-demographic variables on register and in questionnaire
     - Respondent sex, age and marital status, country of birth, household size and whether they have a listed or unlisted fixed line telephone number
  2. Key substantive variables included on the NRFU
     - Subjective wellbeing (life satisfaction, happiness, health, negative affect, stress)

Analytic Approach

Five estimates based on register and questionnaire data:

1. **Target population estimate**
   - Gold standard estimate for the total sample (n=3919)
2. **Survey population estimate**
   - Covered population estimate (for survey 1, coverage = 58.8%)
3. **Sample estimate**
   - Estimate for sub-sample assigned to each of the survey designs
4. **Responding sample estimate**
   - Estimate for the responding sample based on register data
5. **Self-report estimate –**
   - Estimate for the responding sample based on questionnaire data

Analytic Approach

Error components estimated:

Sampling Variance	Square of the standard error for the sample estimate (not comparable due to n)
Noncoverage Bias	Survey population estimate – target population estimate
Nonresponse Bias	Responding sample estimate – sample estimate
Measurement Bias	Self-report estimate – responding sample estimate

Analytic Approach

Error components estimated:

Total Error	Self-report estimate – target population estimate
Mean-Squared Error	$MSE = (B_{NC} + B_{NR} + B_{MEAS})^2 + (Var_{SAMP})$ (additive approach for mixed mode designs)

Not considered:

- **Specification Errors** – Constant across all designs
- **Data Processing Errors** – Esp. in mail survey
- **Measurement Variance** – Esp. interviewer error in CATI

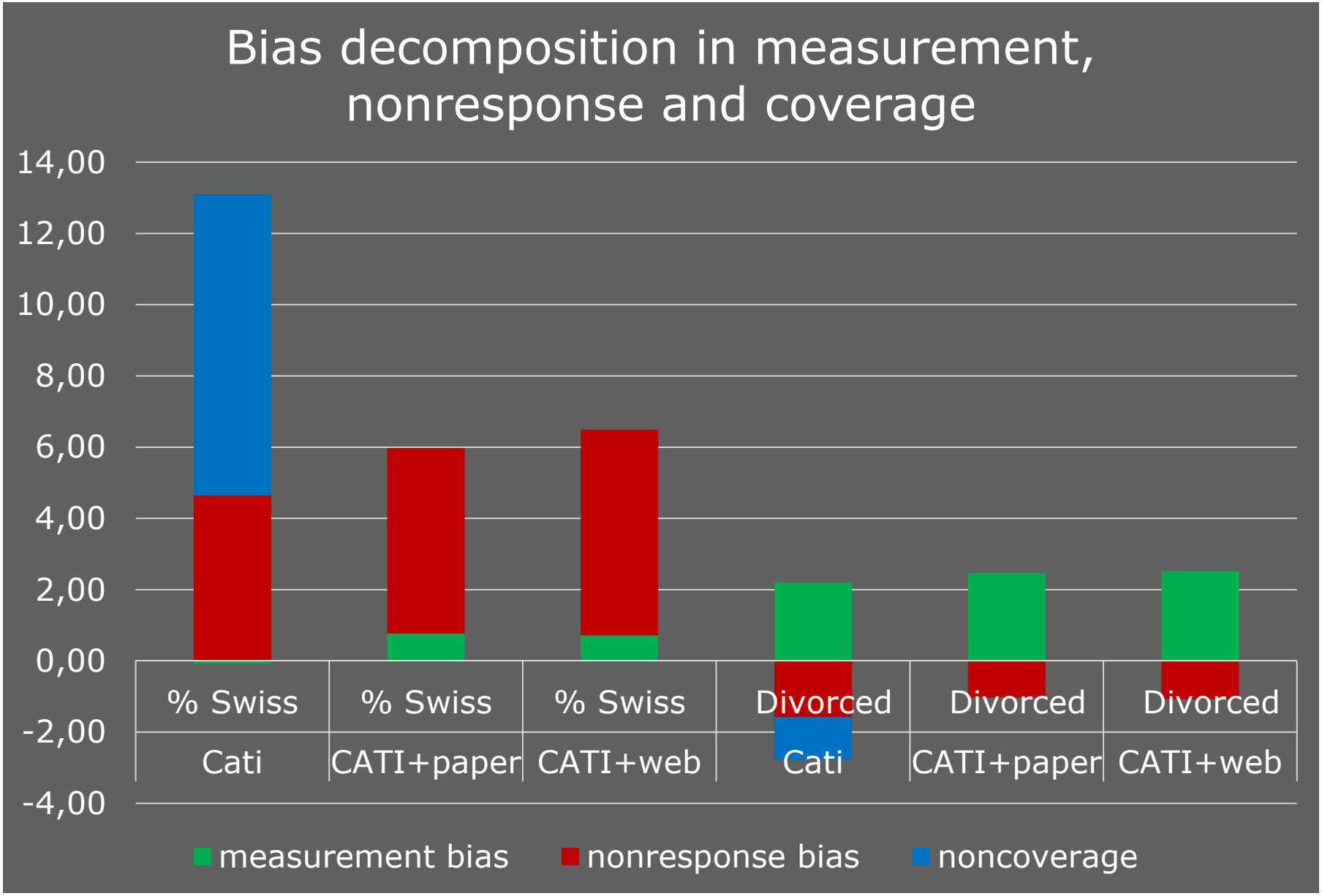
Lumped together in estimate for measurement 'bias'

Results: Total Error by Survey Design

	1: CATI	2: CATI + Mail	3: CATI + Web + Mail
Sex (% male)	-2.80	-4.22	-0.62
Age (mean years)	1.38	-1.38	-0.91
Marital Status (% divorced)	-0,78	1,12	-1,25
Country of Birth (% CH)	14.10	6.66	7.08
Household Size (mean inds)	0.03	-0.07	-0.07
Listed telephone number	41.16	0.10	-0.30

- Mixed mode surveys reduce over-representation of Swiss & people with fixed-line telephones
- Addition of web & mail reduces error on sex and age but not marital status

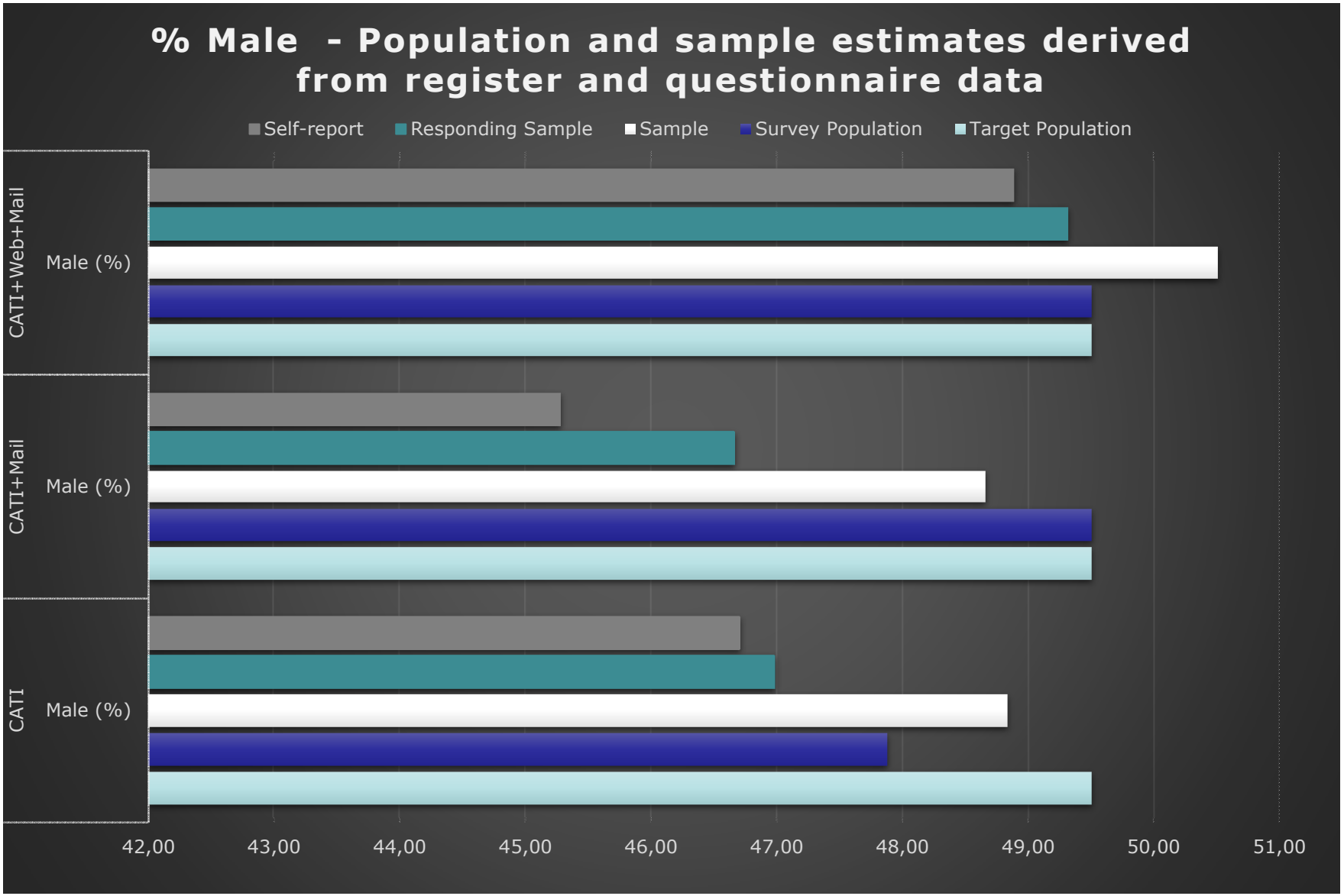
Bias decomposition in measurement, nonresponse and coverage



Results: Error components by survey design - % Male

	1: CATI	2: CATI + Mail	3: CATI + Web + Mail
Total Error	-2.80	-4.22	-0.62
Square root of MSE	4.28	3.90	2.39
Sampling variance	2.04	1.94	1.75
Noncoverage bias	-1.63	0.00	0.00
Nonresponse bias	-1.86	-1.99	-1.20
Measurement bias	-0.27	-1.38	-0.43

- Mixing modes removes noncoverage bias, but adds measurement and nonresponse bias for survey 2. Not the case for survey 3, where the sequential component reduces NRB.
- Total Error is lowest for survey 3 but highest for survey 2

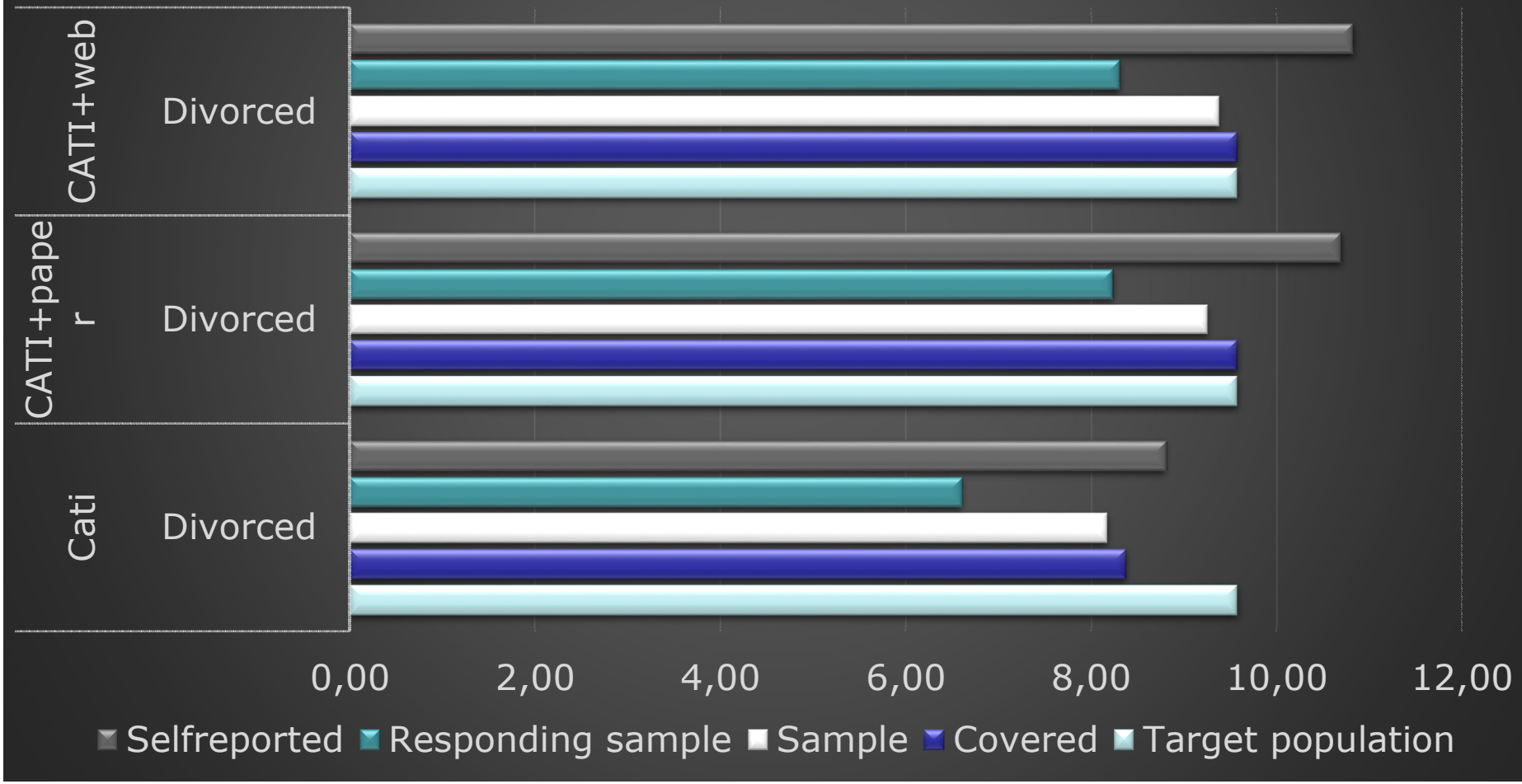

% Male - Population and sample estimates derived from register and questionnaire data
Self-report
Responding Sample
Sample
Survey Population
Target Population
CATI+Web+Mail
Male (%)
CATI+Mail
Male (%)
CATI
Male (%)
42,00
43,00
44,00
45,00
46,00
47,00
48,00
49,00
50,00
51,00

Results: Error components by survey design - % Divorced

	1: CATI	2: CATI + Mail	3: CATI + Web + Mail
Total Error	-0.78	1.12	1.25
Square root of MSE	2.03	3.20	1.99
Sampling error	1.12	1.06	0.92
Noncoverage bias	-1.20	0.00	0.00
Nonresponse bias	-1.57	-1.03	-1.07
Measurement bias	2.20	2.42	2.52

- Mixing modes removes noncoverage bias, reduces non-response bias, but adds measurement bias for surveys 2 and 3.
- Total Error is greater in the mixed mode designs.

% divorced - Population and sample estimates derived from register and questionnaire data

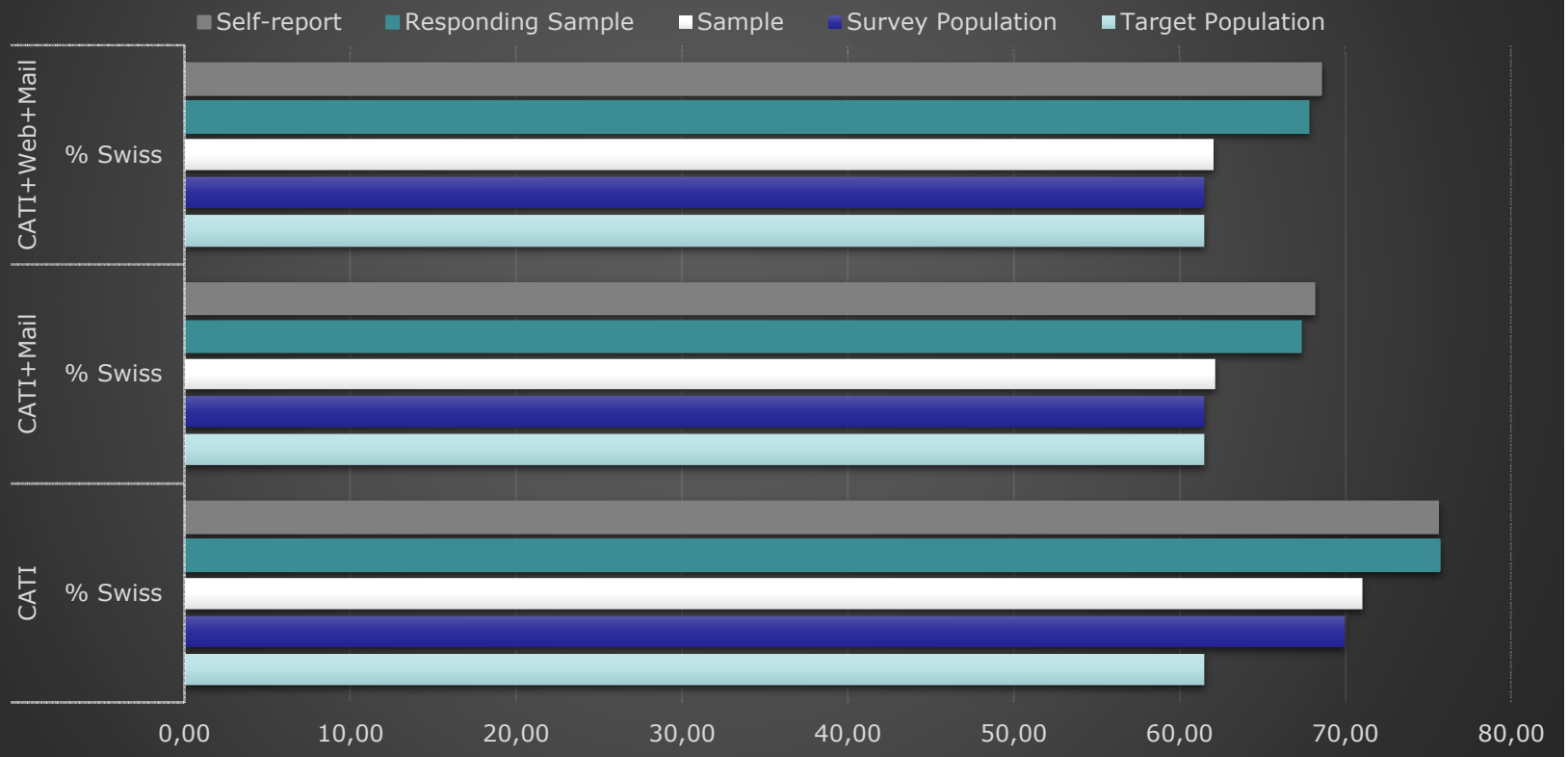


Results: Error components by survey design - % Born in CH

	1: CATI	2: CATI + Mail	3: CATI + Web + Mail
Total Error	14.10	6.66	7.08
Square root of MSE	13.15	6.25	6.68
Sampling variance	1.86	1.82	1.59
Noncoverage bias	8.45	0.00	0.00
Nonresponse bias	4.65	5.20	5.77
Measurement bias	-0.07	0.77	0.72

- Mixing modes removes noncoverage bias, but increases nonresponse bias and measurement bias for surveys 2 and 3.
- Total error is lower in surveys 2 and 3 due to reduction in noncoverage

% Born in CH- Population and sample estimates derived from register and questionnaire data



Summary

1. What is the effect of mixing modes of data collection on the total error of estimates?
   - Pattern of results varies greatly by estimate – total error not always reduced
   - Greatest gain from mixing modes is in representation of foreigners & people without phones
     - Could influence quality of estimates correlated with these – e.g. attitudes to immigration, political participation
2. Which sources of error contribute the most to the total error associated with different types of survey estimate?
   - Varies by estimate for socio-demographic variables considered here
   - Increases in 'measurement bias' likely due to replacement of sample members in self-administered modes or processing errors (e.g. data capture in mail mode)

Next Steps

- Decomposition of errors by mode of data collection for each of the mixed mode designs
- Analysis of additional alternative survey designs
- Analysis of substantive variables, using different approaches to error estimation, including:
  - LCA to assess classification errors in self-report measures of marital status & experience of divorce, and scale reliability for measures of stress and subjective wellbeing
  - Use of NRFU survey to assess nonresponse biases
  - Use of single-mode benchmarks (Mail & Face-to-Face) and post-stratification weighting to assess noncoverage bias

Thank you for your attention!

We welcome your feedback.

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Experiment Design

gross sample size (N)	principal mode	N	1st contact (day 1)	2nd contact (day 4)	3rd contact (day 11)	4th contact (day 26)	5th contact (day 57)	6th contact (day 82)
WITH available telephone number (N= 2100)	**TELEPHONE**	600	prenotification letter with incentive	**CATI** calls, unlimited number of call attempts		**PAPI**	**NRS** by registered mail	end
	PAPER	500	prenotification letter	**PAPI** letter with questionnaire and incentive	reminder by postcard	**PAPI**	**NRS** by registered mail	end
	WEB	1000	prenotification letter	**CAWI** letter with URL, code and incentive	reminder by postcard with URL	URL + **PAPI**	**CATI**	URL + **NRS** by registered mail
WITHOUT available telephone number (N= 1500)	**PAPER**	500	prenotification letter	**PAPI** letter with questionnaire and incentive	reminder by postcard	**PAPI**	**NRS** by registered mail	end
	WEB	1000	prenotification letter	**CAWI** letter with URL, code and incentive	reminder by postcard with URL	URL + **PAPI**	**CAPI**	URL + **NRS** by registered mail

Incentive: 10.- CHF cash
CATI: 25 minutes call on fixed line telephone
PAPI: Printed paper questionnaire
CAWI: Web survey (personalized access with URL and access code)
CAPI: Face to Face contacts with previous contact letter and interview (25-30 minutes)
NRS: Paper Non-Response Survey (1 page 2 sided)

ESS 2012

N=2900 (58% have an available tel. number)	CAPI 60 min. FtF interv	2900	contact letter, 5 FtF contacts, card for non-contacts, CATI contact, FtF refusal conversion, incentive 30.-					**NRS**